# Shotblasting of Aircraft Engine Parts

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An improvement in surface finishing technique has been developed which permits realization of significant savings in time, floor space, abrasive, labor and overhead; but more important, results in a fourfold to tenfold increase in fatigue life.

Shotblasting or "shot-peening", as the technique is termed, has been long familiar to the automotive industry, being at first a cleaning process similar to sandblasting. Its use as a means for increasing fatigue life by putting compression into the surface of a dynamically loaded part apparently began with such parts as valve springs and front wheel suspension springs.

Later, tank parts were shotblasted with encouraging results, and in November, 1942, J. O. Almen of General Motors Research Laboratories, made public the details regarding the mechanics of shotblasting of metal surfaces and suggested means for gaging the extent of the shotblasting technique.

It was only natural that the experience of the automotive industry with shotblasting, plus Almen's detailed study of the stress effects should lead to consideration of application of the method in aircraft engines.

Shotblasting of a "notched" part such as a connecting rod produces greater improvement in fatigue life than is the case on a part with more regular contour such as a crankshaft, but even in the latter case a 30 percent improvement has been effected by shotblasting. Nitriding of the crankshaft has been found to develop a still further improvement in fatigue properties.

Packard some time ago turned to shotblasting of connecting rods for its marine engine, although it required 750 hours of test runs to obtain approval, despite the saving of 30 man-hours production time per engine and increase in fatigue life of rods so treated. These rods are polished with an 80-grit wheel after machining, then shotblasted with 0.027-inch steel shot in four positions, to reach all surfaces. Control is achieved by size of the shot and by time limits in the processing. Cold working of the material by shotblasting results in some distortion, so the practice is to grind the holes in both ends of the rod after shotblasting.

Gears and rocker arms for the same engine also are now being given a gritblast finish. The former was blasted all over with 90-mesh grit after heat treat, with the teeth ground after blasting in most cases. The rocker arms are polished with an 80-grit wheel, giving about 75-microinch profilometer reading, then shotblasted with 0.027-inch steel shot. Saving of 12 man-hours per engine is accomplished by changing the rocker arm finish from the former fine polish.

Profilometer readings of the surface finish by grit blasting or shot-peening do not give a true measure of the effect of the treatment, pointing out that actually it makes no difference what the surface roughness is except that some finishes may be more pleasing to the eye than others.

An important point is the depth of the stressed layer of metal which is in turn related to the time of shotblasting. Some data show 5 to 10 seconds required for each of four passes over a connecting rod. Other vital considerations are the size of the shot, feed and velocity of the shot and distance from the shot outlet to the part. Of these the velocity of the shot is highly important.

Depth of the compressively stressed layer, he observes, is governed by the size of the shot and velocity. The feed is important in providing complete "coverage". The distance from the work affects coverage and velocity. Time in the blast also affects coverage.

Not too much is known about the requirements of shot for prestressing applications, insofar as such factors as size, sphericity, hardness and analysis are concerned. While some of the material is called steel shot, actually it is nearest to a cast iron, prepared by blowing water under pressure against a stream of molten iron.

One thing to be avoided in shotblasting for prestressing is the re-use of fragmented shot whose sharp points may do more harm than good to a machined steel surface. For proper peening action shot must be round and uniform in size, with broken particles screened out. One possibility for making a uniform grade of real steel shot, although at first glance it appears rather costly, is to upset it from steel wire, much in the way BB shot is manufactured.

Some members of the Aircraft Engine Production Committee of the Central Aircraft Council lean to the opinion that there are two drawbacks to finishing engine parts by shotblasting, namely, distortion of thin sections and the tendency to cover up magnaflux indications. Parts such as connecting rods tend to increase in length under

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peening actions. The growth has amounted to as much as 0.008 inch measured at the hole centers. For this reason, one producer provides a new locating spot after shotblasting and then finish machines the piece.

Various protective means have been employed to avoid shotblasting effect upon certain sections of the work. Lead plating has been used. Rubber plugs have been fitted into holes, or rubber shields applied at other points. Disagreement has been expressed concerning bad effects of a juncture between shotblasted and non-treated areas of work pieces. Cracks have appeared in the area not shotblasted, but a line of demarcation between the treated and non-treated areas does not necessarily weaken the part. Wire brushing across the demarcations line has been suggested to avoid cracks.

The most plausible explanation of the effectiveness of surface compression stress is that when a stress in the surface layer is less by the amount of the compression pre-stress and since fatigue failure starts from tension stress, the fatigue durability of the weak surface layer is increased. However, the tension stress in the material below the prestressed layer is not reduced but may be actually increased, nothwithstanding which the fatigue strength of the specimen is increased. It follows, therefore, that the layer is inherently stronger than the surface layer.

Shotblasting may also prove a means of reclaiming parts. In one case four connecting rods were rejected after magnafluxing. After shotblasting no flaws could be discovered. An authority on fatigue stresses stated that in this case surface defects had been corrected by shotblasting.